111518 R

thursday

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Microprocessors

Test 2

100 Points MAX

10 Points

1. You are debugging a PIC32 program and are examining values of 32 bit operands in memory. You examine one location and the value is 0x8000000D. What are the **two** decimal equivalents of this hexadecimal value if the operand is an unsigned integer or a signed integer?

   (Hint: $2^{31} = 2,147,483,648$)

A = 10
B = 11
C = 12
D = 13 = 1101

10

8+4+1=13

2147483648
13
35

1000 1101

Unsigned: $2^{31} + 2^3 + 2^2 + 2^0 = 2,147,483,661$ ✓

Signed: $-(2^{31}) + 2^3 + 2^2 + 2^0 = -2,147,483,635$

12 Points

TABLE 4-2: INTERRUPT REGISTERS MAP FOR PIC32MX440F128L, PIC32MX460F256L AND PIC32MX460F512L DEVICES ONLY(1)

Virtual Address (BF88_#)	Register Name	Bit Range	Bits 31/15	30/14	29/13	28/12	27/11	26/10	25/9	24/8	23/7	22/6	21/5	20/4	19/3	18/2	17/1	16/0	All Resets
1000	INTCON	31:16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	SS0	0000
		15:0	—	—	—	MVEC	—	TPC<2:0>			—	—	—	INT4EP	INT3EP	INT2EP	INT1EP	INT0EP	0000
1010	INTSTAT(2)	31:16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0000
		15:0	—	—	—	—	—	SRIPL<2:0>			—	—	VEC<5:0>						0000
1020	IPTMR	31:16	IPTMR<31:0>																0000
		15:0																	0000
1030	IFS0	31:16	I2C1MIF	I2C1SIF	I2C1BIF	U1TXIF	U1RXIF	U1EIF	SPI1RXIF	SPI1TXIF	SPI1EIF	OC5IF	IC5IF	T5IF	INT4IF	OC4IF	IC4IF	T4IF	0000
		15:0	INT3IF	OC3IF	IC3IF	T3IF	INT2IF	OC2IF	IC2IF	T2IF	INT1IF	OC1IF	IC1IF	T1IF	INT0IF	CS1IF	CS0IF	CTIF	0000
1040	IFS1	31:16	—	—	—	—	—	—	U5BIF	FCEIF	—	—	—	—	DMA3IF	DMA2IF	DMA1IF	DMA0IF	0000
		15:0	RTCCIF	FSCMIF	I2C2MIF	I2C2SIF	I2C2BIF	U2TXIF	U2RXIF	U2EIF	SPI2RXIF	SPI2TXIF	SPI2EIF	CMP2IF	CMP1IF	PMPIF	AD1IF	CNIF	0000
1060	IEC0	31:16	I2C1MIE	I2C1SIE	I2C1BIE	U1TXIE	U1RXIE	U1EIE	SPI1RXIE	SPI1TXIE	SPI1EIE	OC5IE	IC5IE	T5IE	INT4IE	OC4IE	IC4IE	T4IE	0000
		15:0	INT3IE	OC3IE	IC3IE	T3IE	INT2IE	OC2IE	IC2IE	T2IE	INT1IE	OC1IE	IC1IE	T1IE	INT0IE	CS1IE	CS0IE	CTIE	0000
1070	IEC1	31:16	—	—	—	—	—	—	U5BIE	FCEIE	—	—	—	—	DMA3IE	DMA2IE	DMA1IE	DMA0IE	0000
		15:0	RTCCIE	FSCMIE	I2C2MIE	I2C2SIE	I2C2BIE	U2TXIE	U2RXIE	U2EIE	SPI2RXIE	SPI2TXIE	SPI2EIE	CMP2IE	CMP1IE	PMPIE	AD1IE	CNIE	0000
		31:16	—	—	—	INT0IP<2:0>			INT0IS<1:0>		—	—	—	CS1IP<2:0>			CS1IS<1:0>		0000

1 0 0 0 1 0 0 0 0 0 0 0

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2. Using table 4.2 above specify the address and the 32-bit word (expressed as a hexadecimal values) that must be written to it, in order to enable the interrupt for Timer 2.

Address: BF881060 ✓

Word: 0x100

2^0

. . . 0001 0000 000

100

22

5 Points

3. In the PIC microcontroller, we use SFRs. What are SFRs used for and how do they differ from general purpose registers?

SFR: configure ~~data~~ HW & comm w. PERIPH. 4

GPR: save & store data

15 Points

4. You have written the following code and have determined that the size of a short int operand is two bytes.

```
int main( ) {
short int a, b, c

a = 10500;
b= 8;
c = a * b;
printf("The value of c is: %d \n", c);
return 0;
}
```

U: $2^{16} = 65535$

S: -32,768 to 32,767 ✓

```
  111
 32768
 32767
-------
 65535
```

You run the code to test that it works properly and the program output is as follows:

The value of c is: 18464

Is this value correct? If not, why is the product incorrect? (Justify your answer!) 15

```
  4
10500
    8
-----
84000
```

No, the value is incorrect. This is because we used a short int. Here, it is signed, so -32,768 to 32,767, and we don't have enough space for 84000. ✓

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5 Points

5. We need to configure a 32-bit timer in order to measure a time interval which is longer than what we can measure using a 16-bit timer. List one of the timer combinations that can be used for this purpose.

using one w/o a clk, AKA

async ⇒ UART ✗

Timers 2&3 or 4&5 ONLY!

10 Points

6. List the characteristics of a full-duplex, synchronous, serial communication channel. Also, list the minimal set of signal lines that will be needed to connect communicating devices which are configured with these characteristics.

Full Duplex: Simultaneously Transmit & Receive Data ✓

Sync: uses a clock ✓

Serial: one bit at a time ✓

Signal: Ground, Clock, Tx / Transmit, Rx — receive ✓

10

5 Points

7. Which peripheral on the PIC32MX795F512L would we use if we need to implement a half-duplex, synchronous, serial communication channel?

Half dup, Sync & Serial: ✓

5

I^2C

Full Dup, Syn = SIP

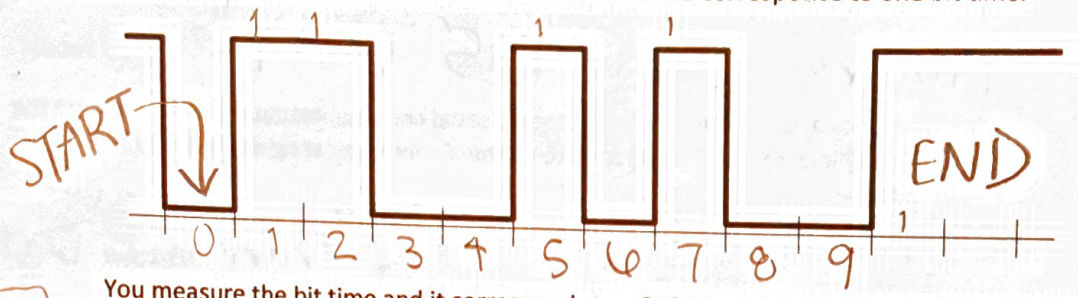
HALF " " = I^2C

Async ⇒ UART

15

10 Points

8. You have configured the UART on your PIC32 microcontroller to communicate at 2400 baud using an 8,N,1 configuration, where the X,Y,Z notation corresponds to data bits, parity, and stop bits. The terminal to which you are connected is transmitting signals to your microcontroller, but the data are not received properly so you instrument the connection with the oscilloscope and observe the following signal, where each tick on the line corresponds to one bit time:



You measure the bit time and it corresponds to a 2400 baud rate. So, why is the data being received erroneously?

8 = data
N = no par.
1 = StopBit

In our configuration, we are given 8 data bits, but in the figure above, it indicates 9 bits could be 8,E,1 or 9,N,1

10

10 Points

9. You are examining a byte of digital data received from the SPI interface. You are processing the received data as ASCII characters. The byte read from the SPI buffer has the following value: 11010011. Is this a valid ASCII character? Why, or why not?

(1) 10010011

This is NOT a valid ASCII character, as a Ø is needed as most sig. bit (msb = Ø) and a 1 is in this position.

10

20 | 19

9 Points

10. There are some restrictions that apply when we are implementing Interrupt Service Routines. List three of these restrictions.

(1) Cannot call ISR
(2) Cannot pass argument to ISR
(3) Should not call functions

9

9 Points

11. What are the three basic requirement that must be met to use interrupts on the PIC microcontroller.

(1) Need interrupt source
(2) Enable interrupt
(3) ISR

9

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① USe PBCLK
T = 0.1 μSec

$\frac{1.65}{0.1\mu S} = 16,500,000$

65,535 max

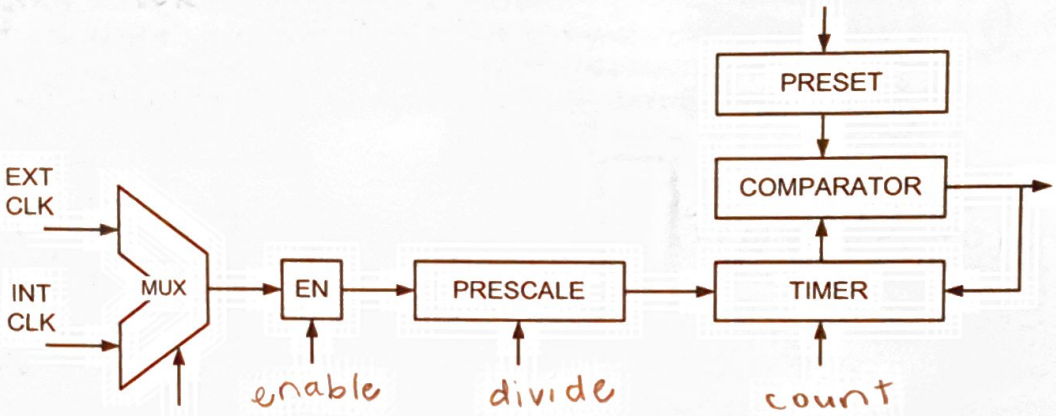
10MHz → 1:256 → Timer

↖ T = 25.6 μS

: 25.6 × 65,535 = 1.677 Sec.

10 Points

12. You are using a 16-bit timer, timer 1, which has pre-scale options of 1:1, 1:8, 1:64, and 1:256. You are using PBCLK, an internal clock, which is configured to run at 10MHz.



Is it possible to set the preset register to a value that corresponds to a time interval of 1.65 seconds, so that the timer can count from 0 to the value and generate an interrupt? You must justify your answer. A yes/no answer will get no points.

SYSCLK ⇒ 80 MHz
PBCLK ⇒ 10MHz
USBCLK ⇒ 48MHz

slower - better and we can use it!

NOT AN OPTION!

Yes, we could use a USBCLK that runs at 48MHz rather than the PBCLK @ 10MHz. By increasing this rate, our prescale could be adjusted to correspond w/ 1.65seconds and generate an interrupt ✗

prove any of the prescale options can be used

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